TOXICOLOGY

HAZARDS

Physical

Biological

Chemical

PHYSICAL HAZARD

Hazards that result from energy and matter and the relationship between the two

HAZARDS

Physical

Biological

Chemical

Biological Hazard
Hazards that cause illness as a consequence of their infectious or toxic properties

HAZARDS

Physical

Biological

Chemical

Chemical Hazard

Hazards that are toxic in one form or another. The dose and exposure determine the amount of reaction

TERMINAL LEARNING OBJECTIVE

- ACTION: Identify the toxic hazards in the aviation environment
- CONDITION: While serving as an aircrew member
- STANDARD: In accordance with (IAW) FM 3-04.301, and the Fundamentals of Aerospace Medicine

Enabling Learning Objective One

- ACTION: Identify the elements of an Occupational Health Program in Army Aviation
- CONDITION: Given a list
- STANDARD: IAW FM 3-04.301, Fundamentals of Aerospace Medicine

History of Occupational Medicine in Aviation

- Occupational Medicine is an essential component of the Army Aviation Medicine Program
- To prevent and solve problems involving potential toxic hazards in the aviation environment

History of Occupational Medicine in Aviation

Hippocrates (400 B.C.)

- First to describe the relationship between work and illness.
- First discussed principles of toxicology during research to control the absorption of a compound to prevent

History of Occupational Medicine in Aviation

“All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy”

History of Occupational Medicine in Aviation

Bernardino Ramazzini's book *"De Morbis Artificum"*. Described numerous diseases caused by exposure to toxins in the work environment. Some of which have undergone very little revision over the past 200 years.

History of Occupational Medicine in Aviation

- First fuel used was a Castor oil mix for lubrication
- Front positioned engine caused a continual mist of castor oil to be sprayed across the pilot's face
- Aviators wore long scarves to wipe mist from their goggles and cover their mouth & nose
- What did the ingested/inhaled castor oil do to the aviator?

History of Occupational Medicine in Aviation

- Currently more than 1 million personnel work in the Aerospace Environment
- Each of these occupations is exposed to toxicological hazards that are unique to their occupation.

QUESTIONS

Enabling Learning Objective Two

- ACTION: Match the terms with the correct definitions
- CONDITION: Given a list of terms and definitions
- STANDARDS: IAW FM 3-04.301 and Fundamentals of Aerospace Medicine

Terms and Definitions

- *Occupational hazard*: Anything capable of producing an adverse health or safety effect on an individual
- *Toxicology*: The scientific study of poisons
- *Exposure*: The *actual contact* of the harmful substance with the biological organism.

Terms and Definitions

Types of Exposure:

- *Acute exposure*: Exposure to an agent over a short period of time that causes adverse health effects
- *Chronic exposure*: A long-term exposure to an agent or a series of repeated exposures to an agent that may eventually lead to adverse health changes.

Terms and Definitions

- *Threshold limit values*(TLV): Concentrations of a chemical that will produce no effects to individuals who are exposed for 8 hours a day
- *Short term exposure limits* (TLV-STEL): Concentration of chemicals that are allowed for exposure times of 15 minutes during the work day
- *Ceiling concentration* (TLV-C): Concentration of a chemical that must never be exceeded during any part of the workday

QUESTIONS

Enabling Learning Objective Three

- ACTION: Match the Aviation toxicology principle with its definition.
- CONDITION: Given a list of terms and definitions
- STANDARD: IAW FM 3-04.301 and Fundamentals of Aerospace Medicine

Aviation Toxicology Principles

- Time and Dose
- Route of Entry
- Rate of Retention and Excretion
- Physiological Effects
- Physiochemical
- Environmental

Aviation Toxicology Principles

- Time and dose principle: Toxin effects depend on the amount and duration of exposure

Aviation Toxicology Principles

- Route of Entry Principle: Ways a toxin can enter the body
  - *Inhalation*
  - *Ingestion*
  - *Absorption*

Aviation Toxicology Principles

- Inhalation: In the flight environment most important method of getting a toxin in the body

Aviation Toxicology Principles

- Ingestion: Involves taking a toxin orally unintentionally

Smoking, eating, or drinking in the work areas without adequate precautions is the main means of exposure through ingestion.

Aviation Toxicology Principles

- Absorption: This involves movement of a toxin through the skin

- Prolonged contact with most Petroleum, oils, lubricants (POLs) may allow for dermal absorption.
- Physical handling of a toxic product is not the only method of absorption
  - Fuel contaminated clothing

Aviation Toxicology Principles

- Rate of Retention and Excretion

  - Retention: How *long* a toxin will remain in the body. (toxins with high retention rates: lead, DDT, Asbestos, Beryllium)

  - Excretion: How *quickly* the body rids itself of the toxin. This is usually through which organs?

Aviation Toxicology Principles

- Physiological: Individual variables that determine the response to a toxin

  - Metabolism: Age, concurrent medication

  - Body Fat: Determines the effect fat soluble toxins have on the body

  - Genetics: Ethnic group, sex

Aviation Toxicology Principles

- Physiochemical: the biochemical process of detoxifying chemicals within the body

Aviation Toxicology Principles

- Environmental: Toxicity may be affected by
  - **Atmospheric pressure**
  - **Temperature**
  - **Humidity**

Aviation Toxicology Principles

- Atmospheric pressure: FAA studies show that hazardous fumes become more toxic at higher altitudes

Plane Lands Itself in Hayfield as Pilot Slumbers

By Douglas R. Burnett

Aviation Toxicology Principles

- Temperature: Toxic agents are less problematic in the winter than summer due to the larger vaporization of volatile chemicals in warmer temperatures.

Aviation Toxicology Principles

- Humidity: Chemicals are more rapidly absorbed through wet (perspiration) skin than cool dry skin

Questions

Enabling Learning Objective Four

- ACTION: Match the aviation toxic substance with the hazard
- CONDITION: Given a list of aviation toxic substances and a list of hazards
- STANDARD: IAW FM 3-04.301 and Fundamentals of Aerospace Medicine

Toxic Substance Overview

- Aviation Fuels and Fuel Combustion products
- Solvents and Degreasers
- Lubricants
- Hydraulic Fluids
- Fire Extinguishers
- Composites and Plastics

Aviation Toxic Substance

- **Aviation Fuels**:
  - Combination of multiple (>20) petroleum products
  - Toluene, xylene, benzene, naphthalene
    - Known carcinogens
  - Army Jet engines use JP-8
    - (Kerosene - principal agent)
    - Flash point of 100 F°
  - Principal hazard is vapor inhalation
  - Symptoms of Exposure

Aviation Toxic Substance

- Aviation Fuel Symptoms of Acute Exposure
  - Neurological symptoms:

    Light-headedness, confusion, fatigue, coma, slurred speech, respiratory failure, impaired psychomotor
  - Cardiac and Respiratory symptoms:

    Irregular heart beats, coughing, choking, wheezing
  - Gastrointestinal symptoms:

    Nausea, vomiting, easily absorbed through mouth
  - Skin symptoms:

    Chemical burns, irritation due to the drying effect

Aviation Toxic Substance

- Aviation Fuel Combustion

  - *Carbon Monoxide*: One of the most common and toxic of substances in the aviation environment

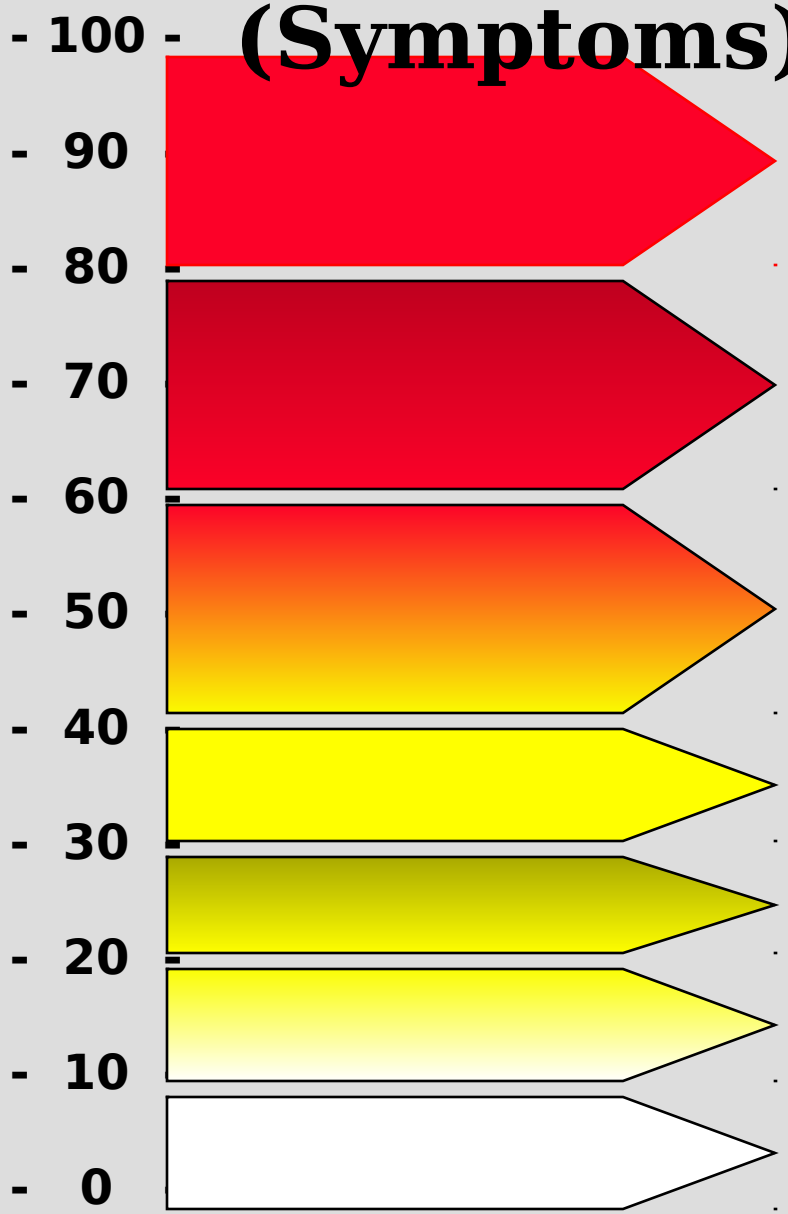
  - Low concentrations over time can produce high blood concentration

Aviation Toxic Substance

Carbon Monoxide

- Most common cause of fatal poisonings in USA
- Product of incomplete combustion
- CO is a colorless, odorless gas
- CO 0.5% for 30 minutes = Blood Conc of 45%
- With as little as 10% Carboxyhemoglobin can decreased peripheral and night vision.
- After removal from CO source, only about 0.5% is removed from blood every 4 hours.

Carbon Monoxide (Symptoms)



Immediate Death

Unconsciousness, Respiratory Failure, Death in Long Exposures

Headache, Disorientation, Fainting, Collapse

Pronounced Headache, Fatigue, Irritability, **Impaired Judgment**

Extreme Shortness of Breath during Moderate Exertion, Minor Headache

No major effect except for Shortness of Breath on Extreme Physical Activity

No effect

Aviation Toxic Substance

- **Solvents and Degreaser**: Organic bases used to dissolve other petroleum products (Water, Lipid)

  - Toluene isocynate: an additive to paints, foams, and adhesives

  - Trichloroethylene (TCE): Used in aircraft maintenance as solvent or degreasing agent

  - Methyl-ethyl-ketone (MEK): Solvent specified by the maintenance manual

Aviation Toxic Substance

- **Lubricants**

  - Substances that reduce friction

  - Located in Engine , APU, Transmission, and gear boxes

  - When exposed to hot surfaces an inhalation hazard is produced, symptoms similar to CO

  - Skin contact causes a dermatitis reaction

Aviation Toxic Substance

- **<u>Hydraulic Fluids</u>**
  - Petrolatum, Castor oil, Silicon, or Phosphate Ester based
  - Maintained under high pressure and a small leak can produce a finely aerosolized mist in the cockpit.
  - Fine mist can impair vision and act as an irritant. Inhalation can irritate the lungs.
  - Large leak can cause pooling in the cockpit

Aviation Toxic Substance

- **Fire Extinguishers**

  - A threat when operated in an enclosed or open environment

  - Inhalation is the primary threat

- **Three Types**
  - **Halon**
  - **Carbon Dioxide**
  - **Aqueous Film Forming Foam**

Aviation Toxic Substance

- **Halon**

  - Liquefied compressed gas which chemically interrupt combustion

  - Non-toxic unless discharged within an enclosed space

  - Decomposes into (hydrogen fluoride, chloride, bromide and phosgene

Aviation Toxic Substance

- **Carbon Dioxide**
  - Safe, large quantities needed
  - Heavier than air
  - In low concentrations (< 2%) acts as a respiratory stimulant
  - High concentration (2-5%), drowsiness, headache, respiratory, loss of concentration
  - At 10% or above, collapse, LOC, and death can occur

Aviation Toxic Substance

- **Aqueous Film Forming Foam**

  - Relatively nontoxic protein based product

  - The concentrated foam is harsh and can irritate the skin

Aviation Toxic Substance

- **<u>Composite and Plastic</u>**

  - Composed of a number of components which give strength, thermal resistance, light-weight
  - Composed of resins, fibers, solvents

Aviation Toxic Substance

- **Fibers**

  - Include graphite, boron, kevlar, and or fiberglass

  - Problems occur during crash, working, burning, sanding, or scraping

  - Primary hazard is inhalation of particles < 3.5 micrometer.

  - Can develop asbestosis type reaction

Aviation Toxic Substance

- **Resins**

  - Bonding agents, hold the fibers in a matrix

  - Epoxy, polyurethane, phenol, and amino resins make up the bonding agents

  - Primary hazard is inhalation due to thermal release of toluene diisocyantes, methylene dianiline(MDA) fumes

  - CNS depression, unconsciousness, allergic reaction

Aviation Toxic Substance

- **Plastics**

  - Polyurethane used in cockpit/cabin interiors and fluorocarbon plastics used in wiring insulation and corrosion resistant coating
  - Primary hazard is inhalation during decomposition, which may release cyanide, fluorine gas and phosgene

Questions

QUESTIONS

Enabling Learning Objective Five

- ACTION: Identify protective measures to prevent or reduce toxic substance exposure.
- CONDITION: Given a list
- STANDARD: IAW FM 3.04-301, AR 50-3 AR 50-6

Protective Measures

- **<u>Individual</u>**

  - Prevent contamination of your ABDU / NOMEX flight suits

  - Smoke and eat only in authorized areas

  - Hand Washing decreases risk of ingesting a toxin.

  - Wear personal protective equipment (PPE)

  - Pay attention to your physical symptoms (headache, burning eyes, choking, nausea, and / or skin irritation)

Protective Measures

- **<u>Cockpit</u>**

  - Be aware of the potential for toxic exposure in flight

  - Smoke and fumes are a very serious matter

  - Take immediate action; ventilate, descend, land, evacuate the aircraft, and seek medical evaluation

Protective Measures

- **General**

  - Be aware of the potential for toxic exposure in the aviation environment

  - Be aware of the hazardous material in your work area

  - Develop and rehearse evacuation plan

Summary

- Occupational Health In Army Aviation
- Terms and Definitions in Aviation Toxicology
- Aviation Toxicology Principles and Definitions
- Aviation Toxic Substances and Hazards
- Protective Measures

QUESTIONS